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# Report on Waste Disposal Charges

## Changes in Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities

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## Abstract

A requirement placed upon nuclear power reactor licensees by the U.S. Nuclear Regulatory Commission (NRC) is that licensees must annually adjust the estimate of the cost of decommissioning their plants, in dollars of the current year, as part of the process to provide reasonable assurance that adequate funds for decommissioning will be available when needed. This report, which is revised periodically, explains the formula that is acceptable to the NRC for determining the minimum decommissioning fund requirements for nuclear power plants. The sources of information used in the formula are identified, and the values developed for the estimation of radioactive waste burial/disposition costs, by site and by year, are given. Licensees may use the formula, coefficients, and burial/disposition adjustment factors from this report in their cost analyses, or they may use adjustment factors at least equal to the approach presented herein.

New to this report is the inclusion of an alternative low-level waste (LLW) disposition option other than direct disposal at the two remaining operating LLW burial sites. This new option, which is accepted as a valid approach for consideration by licensees, is to contract with waste vendors to provide for the disposition of LLW generated during decommissioning.

This eighth revision of NUREG-1307 contains updated disposal costs for the reference pressurized water reactor (PWR) and the reference boiling water reactor (BWR) and the ratios of disposal costs at the two remaining burial sites in Washington and South Carolina for the year 1998. In addition, disposal costs for the reference reactors and ratios of disposal costs at the Washington, Nevada, and South Carolina sites for the years 1986, 1988, 1991, 1993, 1994, 1995, 1996, and 1997 are provided for historical purposes. This report also provides costs for dispositioning a portion of the total LLW volume using waste vendors, including the ratios of these costs relative to the original 1986 disposal cost estimates. Future updates of NUREG-1307 will provide revised estimates for this alternative LLW disposition option in addition to the direct disposal option. Several sample calculations for estimating the burial/disposition cost for both the old and new options are presented, demonstrating the use of the data contained in this report.

Estimated disposal costs at the Washington site increased by 2% for the reference PWR and 130% for the reference BWR over corresponding estimates for 1997. The large increase for disposal of BWR LLW was primarily due to tripling of the exposure dose rate charges for BWR and to doubling of disposal charges per container and shipment for both PWRs and BWRs. Estimated disposal costs at the South Carolina site remained essentially unchanged (<1% increase) with only the addition of a revised site access fee. The cost of LLW disposition using waste vendors is about 50% less than direct disposal at the South Carolina burial site. At the Washington burial site, however, the waste vendor option is about 5% (BWR) and 40% (PWR) greater than direct disposal.



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## Foreword

Nuclear power reactor licensees are required, per 10 CFR 50.75, to adjust annually the estimated decommissioning costs of their nuclear facilities in order to ensure adequate funds are available for decommissioning. The regulation references NUREG-1307 as the appropriate source for obtaining the adjustment factor for waste burial/disposition costs; this Revision 8 of NUREG-1307 provides the current waste burial costs at the Washington and South Carolina disposal sites. In addition, this revision, for the first time, provides costs for low-level radioactive waste disposition using waste vendors. Licensees can factor these numbers into the adjustment formula, as specified in 10 CFR 50.75(c)(2), to determine the minimum decommissioning fund requirement for their nuclear facilities.

Although this report is specifically prepared for the use of power reactor licensees, it can also be a valuable source of information for material licensees on current waste burial/disposition costs. After July 1, 1994, access to the Barnwell, South Carolina, facility was limited to Southeast Compact waste generators. Effective July 1, 1995, the scheduled closure date, December 31, 1995, was canceled and access to the Barnwell facility was extended to waste generators from all States except North Carolina. At the Richland, Washington, facility, disposal rates are determined annually based on waste generator volume projections and a maximum operator revenue set by the Washington Utilities and Transportation Commission. If the total operator revenue is exceeded in a given year, a rebate may be sent to the waste generator.

It is important to note that there is an additional waste disposal facility that may be used in certain specific circumstances by licensees. That facility is operated by Envirocare in Utah and is designed to accept high volume (bulk), low-activity, low-level radioactive waste. However, that facility does not offer the range of disposal capability needed by power reactor licensees that the other established disposal sites provide. That facility also does not issue a rate schedule of waste disposal charges. For these reasons, the Envirocare facility is not included as a reference burial site in this report.

Another option now available to licensees for the disposition of their LLW is to contract with waste vendors to provide these services. Licensees are increasingly recognizing that, generally, waste vendors are more effective at identifying the lowest cost solutions to LLW disposition. This revision of the report provides, for the first time, waste burial/disposition adjustment factors for the waste vendor option, in addition to the standard option of direct disposal at the two available disposal facilities.

Low-level radioactive waste disposal costs are an important element in the cost of decommissioning a nuclear facility. This report provides the latest information that was available at time of publication for licensees to use for annually adjusting the estimated cost of decommissioning their nuclear facilities.

John W. Craig, Director  
Division of Regulatory Applications  
Office of Nuclear Regulatory Research

## 1 Introduction

In 10 CFR 50.75(b), the U.S. Nuclear Regulatory Commission (NRC) requires nuclear power plant licensees to annually adjust the estimate of the cost (in dollars of the current year) of decommissioning their plants. This is just one step of a multi-step process of providing reasonable assurance to the NRC that adequate funds for decommissioning will be available when needed. This report provides adjustment factors for the waste burial/disposition component of the decommissioning fund requirement, as required by 10 CFR 50.75(c)(2). This report also provides the regional adjustment factors for the labor and energy components of the decommissioning fund requirement. The term "adjustment factor," as used in this report and in 10 CFR 50.75(c)(2), refers to increases and/or decreases in decommissioning costs since the NRC regulations were issued. The decommissioning fund requirements in these regulations are in 1986 dollars. This report is periodically updated to reflect changes in waste burial/disposition costs.

Provided within this report is the development of a formula for estimating decommissioning cost that is acceptable to the NRC. The sources of information used in the formula are identified, and the values developed for the adjustment of radioactive waste burial/disposition costs, by site and by year, are given in this report. Licensees may use the formula, the coefficients, and the burial/disposition adjustment factors from this report in their analyses, or they may use an adjustment rate at least equal to the approach presented herein.

The formula and its coefficients, together with guidance to the appropriate sources of data needed, are summarized in

Chapter 2. The development of the formula and its coefficients, with sample calculations, are presented in Chapter 3. Price schedules for burial/disposition for 1998 are given in Appendix A for currently operating burial sites and waste vendors. The calculations to determine the burial/disposition cost factors,  $B_i$ , for each site and each year of evaluation are summarized in Appendix B.

This eighth revision of NUREG-1307 contains updated low-level waste (LLW) burial/disposition costs for the reference pressurized water reactor (PWR) and the reference boiling water reactor (BWR) and the ratios of LLW burial/disposition costs at the two remaining burial sites in Washington and South Carolina for the year 1998. In addition, disposal costs for the reference reactors and ratios of disposal costs at the Washington, Nevada, and South Carolina sites for the years 1986, 1988, 1991, 1993, 1994, 1995, 1996, and 1997 are provided for historical purposes. In addition to direct disposal at the two remaining burial sites, this report also, for the first time, includes the option of LLW disposition by waste vendors.

Burial cost surcharges mandated by the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPA) have been incorporated into the revised ratio tables for the years 1986, 1988, and 1991, and are provided in Appendix D. The provisions in the Act that mandated these surcharges expired at the end of 1992. Thus, the values of the ratios of disposal costs calculated for the years 1993 and later do not include the LLRWPA surcharges.



## 2. Summary

The elements of decommissioning cost, per 10 CFR 50.75(c)(2), are assigned to three categories: those that are proportional to labor costs,  $L_x$ ; those that are proportional to energy costs,  $E_x$ ; and those that are proportional to burial costs,  $B_x$ . The adjustment of the total decommissioning cost estimate can be expressed by

$$\text{Estimated Cost (Year X)} = [1986 \$ \text{ Cost}] [A L_x + B E_x + C B_x]$$

where A, B, and C are the fractions of the total 1986 dollar costs that are attributable to labor (0.65), energy (0.13), and burial (0.22), respectively, and sum to 1.0. The factors  $L_x$ ,  $E_x$ , and  $B_x$  are defined by

$L_x$  = labor cost adjustment, January of 1986 to January of Year X.

$E_x$  = energy cost adjustment, January of 1986 to January of Year X, and

$B_x$  = LLW burial/disposition cost adjustment, January of 1986 to January of Year X (i.e., burial/disposition cost in January of Year X / burial cost in January of 1986).

Licensees are to evaluate  $L_x$  and  $E_x$  for the years subsequent to 1986 based on the national producer price indices, national consumer price indices, and on local conditions for a given site (see Chapter 3).

$B_x$  is evaluated by recalculating the costs of burial/disposition of the radioactive wastes from the reference PWR (Ref. 1) and the reference BWR (Ref. 2) based on the price schedules provided by the available burial sites/waste vendors for the year of interest. The results of these recalculations are presented in Table 2.1, by site and by year. Previous issues of this report had considered direct burial of LLW at an available LLW disposal site as the only LLW disposition option. This update includes the additional LLW disposition option of turning the majority of the LLW generated during decommissioning over to waste vendors for disposition. The  $B_x$  values for this option are provided in Table 2.1 for 1998 (see footnote (e) at the bottom of the table). It is left to the licensees to determine

whether direct disposal or disposition using waste vendors best represents their particular situation.

**Table 2.1 Values of  $B_x$  as a Function of LLW Burial Site, Waste Vendor, and Year**

Year	Values of $B_x$ (PWR/BWR) <sup>(a)</sup> (No Surcharges, No Penalties)		
	Washington	Nevada	South Carolina
1998	3.165/14.403 <sup>(b)</sup> 4.538/15.203 <sup>(b, c)</sup>	--- / --- <sup>(e)</sup> --- / --- <sup>(c)</sup>	15.886/13.948 <sup>(d)</sup> 7.173/6.968 <sup>(d, e)</sup>
1997	3.112/6.264 <sup>(b)</sup>	--- / --- <sup>(c)</sup>	15.852/13.837 <sup>(d)</sup>
1996	2.845/3.294 <sup>(b)</sup>	--- / --- <sup>(c)</sup>	12.771/10.379 <sup>(d)</sup>
1995	2.015/1.878 <sup>(b)</sup>	--- / --- <sup>(c)</sup>	12.824/10.420 <sup>(d)</sup>
1994	2.521/2.373 <sup>(b)</sup>	--- / --- <sup>(c)</sup>	11.873/9.794 <sup>(d)</sup>
	--- / ---	--- / ---	6.619/5.714 <sup>(d)</sup>
1993	2.002/1.943 <sup>(b)</sup>	--- / --- <sup>(c)</sup>	11.408/9.434 <sup>(d)</sup>
	--- / ---	--- / ---	6.155/5.354 <sup>(d)</sup>
1991	1.326/1.184	1.334/1.296	2.494/2.361
1988	1.223/1.093	1.193/1.175	2.007/1.831
1986	1.000/1.000	0.857/0.898	1.678/1.561

(a) The values presented in this table are developed in Appendix B, with all values normalized to the 1986 Washington (PWR/BWR) values with no LLRWPA surcharges or penalties by dividing the calculated burial costs for each site and year by the Washington site burial costs calculated for the year 1986.

(b) Effective 1/1/93, the Washington site is not accepting waste from outside the Northwest and Rocky Mountain Compacts.

(c) Nevada site closed 12/31/92.

(d) Effective 7/1/95, access is allowed for all states except North Carolina.

(e) Effective with the 1998 update of NUREG-1307, turning over the majority of LLW to waste vendors for disposition is considered a possibility.

(f) Includes \$220/ft<sup>3</sup> out-of-region access fee.

(g) Includes \$74/ft<sup>3</sup> in-region access fee.

Consideration of LLRWPA surcharges and penalties (which ceased being imposed on January 1, 1993) is given in Appendix D for historical purposes. As noted in the footnotes to Table 2.1, the LLW disposal site in Nevada ceased operation as of December 31, 1992, and is therefore

### 3 Development of Cost Adjustment Formula

The evaluations presented in this chapter are based on information presented in NUREG/CR-0130 (Addendum 4) and NUREG/CR-0672 (Addendum 3) (Refs. 1, 2), in which the estimated costs for immediate dismantlement of the reference PWR and the reference BWR are adjusted to January 1986 dollars. Decommissioning costs are divided into three general areas per 10 CFR 50.75(c)(2) that tend to escalate similarly: (1) labor, materials, and services, (2) energy and waste transportation, and (3) radioactive waste burial/disposition. A relatively simple equation can be used to determine the minimum decommissioning fund requirement in 1998 or previous year dollars. That equation is

$$\begin{aligned} \text{Estimated Cost (Year x)} \\ = [\text{1986 \$ Cost}] * (A L_x + B E_x + C B_x) \end{aligned}$$

where

- Estimated Cost (Year x)  
= estimated decommissioning costs in Year x dollars,
- [1986 \$ Cost]  
= estimated decommissioning costs in 1986 dollars,
- A = fraction of the [1986 \$ Cost] attributable to labor, materials, and services (0.65)
- B = fraction of the [1986 \$ Cost] attributable to energy and transportation (0.13)
- C = fraction of the [1986 \$ Cost] attributable to waste burial (0.22)
- L = labor, materials, and services cost adjustment, January of 1986 to January of Year x
- E = energy and waste transportation cost adjustment, January of 1986 to January of Year x
- B = radioactive waste burial/disposition and surcharge cost adjustment, January of 1986 to nominally January of Year x (i.e.,

burial/disposition cost in nominally January of Year x / burial cost in January of 1986)

$$= (R_x + \sum S_x) / (R_{1986} + \sum S_{1986})$$

where:

$R_x$  = radioactive waste burial/disposition costs (excluding surcharges) in Year x dollars

$\sum S_x$  = summation of surcharges in Year x dollars

$R_{1986}$  = radioactive waste burial costs (excluding surcharges) in 1986 dollars

$\sum S_{1986}$  = summation of surcharges in 1986 dollars.

Values for  $L_x$  and  $E_x$  for years subsequent to 1986 are to be based on the national producer price indices, national consumer price indices, and local conditions for a given site, as outlined in Sections 3.1 and 3.2. Thus, the licensee can evaluate these parameters appropriately for a particular site. The values to be used in determining  $B_x$  are taken from actual cost schedules and from price quotes by waste vendors.

Prior to 1993, calculation of  $B_x$  included basic disposal costs plus surcharges resulting from the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPA). Surcharges mandated by the LLRWPA were applied to wastes generated outside the regional waste compact in which the LLW burial facility is located. As of January 1992, surcharges were \$40/ft<sup>3</sup> for wastes generated within a compact which has met the milestones given in the LLRWPA toward implementing an LLW disposal facility in their compact and \$120/ft<sup>3</sup> (\$40/ft<sup>3</sup> surcharge plus \$80/ft<sup>3</sup> penalty) for wastes generated within a compact which has not met the milestones given in the LLRWPA toward implementing an LLW disposal facility in their compact. After December 31, 1992, no LLRWPA surcharges are assessed and are therefore no longer applicable to the calculation of  $B_x$ . Values of  $B_x$  for 1998, and earlier years, are provided to the licensee via this report for information purposes only, as described in Section 3.3.

## Adjustment Formula

The major elements of the three components of the decommissioning cost estimates for both the reference PWR and BWR are provided in Table 3.1. Considering the uncertainties and contingencies contained within these numbers, and considering that the values of the coefficients for the PWR and the BWR are so similar, the best estimates of their values are their averages:

$$\bar{A} = 0.65 \quad \bar{B} = 0.13 \quad \bar{C} = 0.22$$

for both the PWR and BWR estimates.

## 3.1 Labor Adjustment Factors

The adjustment factor for labor,  $L_a$ , can be obtained from "Monthly Labor Review," published by the U.S. Department of Labor, Bureau of Labor Statistics (BLS) (Ref. 4). Specifically, the appropriate regional data from the table (currently Table 24) entitled "Employment Cost Index, Private Nonfarm Workers, by Bargaining Status, Region, and Area Size," subtitled "Compensation," should be used. These labor adjustment factors can also be obtained from BLS databases made available on the World Wide Web (see Appendix C for instructions).  $L_a$  should be adjusted from a base value in Table 24 corresponding to the amounts in the decommissioning rule amendments that are in January 1986 dollars.

Table 3.1 Evaluation of the Coefficients A, B, and C in January 1986 Dollars

Cost Category	Reference PWR Values		Reference BWR Values	
	1986 \$ (millions)	Coefficient	1986 \$ (millions)	Coefficient
Labor	17.98 <sup>(a)</sup>		35.12 <sup>(b)</sup>	
Equipment	1.64 <sup>(a)</sup>		4.03 <sup>(b)</sup>	
Supplies	3.12 <sup>(a)</sup>		3.71 <sup>(b)</sup>	
Contractor	12.9 <sup>(a)</sup>		21.1 <sup>(a)</sup>	
Insurance	1.9 <sup>(a)</sup>		1.9 <sup>(a)</sup>	
Containers	10.9 <sup>(a)</sup>		8.14 <sup>(a)</sup>	
Added Staff	7.5 <sup>(a)</sup>		4.4 <sup>(a)</sup>	
Added Supplies	1.2 <sup>(a)</sup>		0.2 <sup>(a)</sup>	
Spec. Contractor	0.78 <sup>(a)</sup>		0.71 <sup>(a)</sup>	
Pre-engineering	7.4 <sup>(a)</sup>		7.4 <sup>(a)</sup>	
Post-TMI-backfits	0.9 <sup>(a)</sup>		0.1 <sup>(a)</sup>	
Surveillance	0.31 <sup>(a)</sup>		—	
Fees	0.14 <sup>(a)</sup>		0.14 <sup>(a)</sup>	
Subtotal	66.67	A = 0.64	86.95	A = 0.66
Energy	8.31 <sup>(a)</sup>		8.84 <sup>(b)</sup>	
Transportation	6.08 <sup>(a)</sup>		7.54 <sup>(c)</sup>	
Subtotal	14.39	B = 0.14	16.38	B = 0.12
Burial	22.48 <sup>(d)</sup>	C = 0.22	29.98 <sup>(c)</sup>	C = 0.22
Total	103.54		133.31	

Note: All costs include a 25% contingency factor.

(a) Based on Table 3.1, NUREG/CR-0130, Addendum 4.

(b) Based on Table 3.1, NUREG/CR-0672, Addendum 3.

(c) Based on Table 5.2, NUREG/CR-0672, Addendum 3.

(d) Based on Table 6.2, NUREG/CR-0130, Addendum 4.

## Adjustment Formula

To calculate a labor adjustment factor for a particular region, two indices and a scaling factor are needed. These values are shown in Table 3.2 for each region. The base index of  $L_r$  from the BLS data for January 1986 is listed in Column 2 of Table 3.2. These values are based on an index value of 100 in June 1981 (Base June 1981 = 100). However, current BLS index values (1997) are based on an index value of 100 in June 1989 (Base June 1989 = 100). These values are shown in column 3. To convert between these two indices, regional scaling factors are needed. These scaling factors are listed in the last column in Table 3.2.

Table 3.2 Regional Factors for Labor Cost Adjustment

Region	1986 Reference (Base June 1981 = 100)	Current Year (1997) (Base June 1989 = 100)	Scaling factor
Northeast	130.5	135.0	1.555
South	127.7	134.6	1.441
Midwest	125.0	136.9	1.409
West	130.1	133.4	1.449

In general,  $L_r$  is calculated for each region by multiplying the 1997 value (column 3) by the scaling factor (column 4) and then dividing by the reference value (column 2). For example, for the Northeast region:

$$L_r = \frac{(135.0)_{\text{Base 1989 (column 3)}} \times (1.555)_{\text{Base 1981/Base 1989 (column 4)}}}{(130.5)_{\text{Base 1981 (column 2)}}} = 1.609$$

This value of  $L_r = 1.609$  should then be used in the equation to adjust the labor cost (to January 1998 dollars) for decommissioning a nuclear power plant located in the Northeast region of the U.S.

### 3.2 Energy Adjustment Factors

The adjustment factor for energy,  $E_r$ , can be obtained from the "Producer Price Indexes," published by the U.S. Department of Labor, Bureau of Labor Statistics (BLS) (Ref. 5). Specifically, data from the table (currently Table 6) entitled "Producer Price Indexes and Percent Changes for

Commodity Groupings and Individual Items" (PPI) should be used.

$E_r$  is made up of two components, namely, industrial electric power,  $P_r$ , and light fuel oil,  $F_r$ . Hence,  $E_r$  should be obtained using the BLS data in the following equations: for the reference PWR,  $[0.58P_r + 0.42F_r]$  and for the reference BWR,  $[0.54P_r + 0.46F_r]$ . These equations are derived from Table 6.3 of Reference 1 and Table 5.3 of Reference 2.  $P_r$  should be taken from data for industrial electric power (Commodity code 0543 in Table 6), and  $F_r$  should be taken from data for light fuel oils (Commodity code 0573 in Table 6). These energy adjustment factors can also be obtained from BLS databases made available on the World Wide Web (see Appendix C for instructions).

As discussed for  $L_r$  in Section 3.1 above,  $P_r$  and  $F_r$  should be adjusted from a base value in the BLS table corresponding to the amounts in the decommissioning rule amendments that are in January 1986 dollars. The base values of  $P_r$  and  $F_r$  from the BLS data for January 1986 are 114.2 and 82.0, respectively. No regional BLS data for these PPI commodity codes are currently available. All PPI values are based on a value of 100 for the year 1982 (Base 1982 = 100). Thus, the values of  $P_r$  and  $F_r$  for December 1997 (latest data available) are

$$P_r = \frac{128.3 \text{ (the December 1997 value)}}{114.2 \text{ (the January 1986 value)}} = 1.123$$

$$F_r = \frac{59.4 \text{ (the December 1997 value)}}{82.0 \text{ (the January 1986 value)}} = 0.724$$

The value of  $E_r$  for the reference PWR is therefore

$$E_r = [(0.58 \times 1.123) + (0.42 \times 0.724)] = 0.955$$

This value of  $E_r = 0.955$  should then be used in the equation to adjust the energy cost (to January 1998 dollars) for decommissioning a PWR. Correspondingly, for a BWR,  $E_r = 0.939$ .

### 3.3 Waste Burial Adjustment Factors

The adjustment factor for waste burial/disposition,  $B_r$ , can be taken directly from data on the appropriate LLW burial location as given in Table 2.1 of this report. For example,

## Adjustment Formula

$B_r = 15.886$  (in 1998 dollars) for a PWR directly disposing all decommissioning LLW at the South Carolina burial site.

### 3.4 Sample Calculations of Estimated Reactor Decommissioning Costs

Several sample calculations are provided in this section to demonstrate the use of the decommissioning cost equation developed above using the appropriate adjustment terms of  $L_r$  for labor, material, and services,  $E_r$  for energy and waste transportation, and  $B_r$  for radioactive waste burial/disposition.

#### Example 1 (LLW Direct Disposal)

##### Scenario Description

Reactor Type: PWR  
Thermal Power Rating: 3400 MW<sub>th</sub>  
Location of Plant: Western Region of the U.S.  
LLW Disposition Preference: Direct Disposal  
LLW Burial Location: Washington

Base Cost (1986 Dollars) = \$105 million [from 10 CFR 50.75(c)(1)]

$L_r = (133.4)^*(1.449)/(130.1) = 1.486$  [from Table 3.2]

$E_r = 0.955$  [from Section 3.2]

$B_r = 3.165$  [from Table 2.1]

Decommissioning Cost (1998 Dollars)  
= (\$105 million)\*[(0.65)\*(1.486)+(0.13)\*(0.955)+(0.22)\*(3.165)]  
= \$188 million

#### Example 2 (LLW Direct Disposal)

##### Scenario Description

Reactor Type: PWR  
Thermal Power Rating: 3400 MW<sub>th</sub>  
Location of Plant: Northeast Region of the U.S.  
LLW Disposition Preference: Direct Disposal  
LLW Burial Location: South Carolina

Base Cost (1986 Dollars) = \$105 million [from 10 CFR 50.75(c)(1)]

$L_r = (135.0)^*(1.555)/(130.5) = 1.609$  [from Table 3.2]

$E_r = 0.955$  [from Section 3.2]

$B_r = 15.886$  [from Table 2.1]

Decommissioning Cost (1998 Dollars)  
= (\$105 million)\*[(0.65)\*(1.609)+(0.13)\*(0.955)+(0.22)\*(15.886)]  
= \$490 million

#### Example 3 (LLW Disposition by Waste Vendors)

##### Scenario Description

Reactor Type: PWR  
Thermal Power Rating: 3400 MW<sub>th</sub>  
Location of Plant: Northeast Region of the U.S.  
LLW Disposition Preference: Contract with Waste Vendors  
LLW Burial Location: South Carolina

Base Cost (1986 Dollars) = \$105 million [from 10 CFR 50.75(c)(1)]

$L_r = (135.0)^*(1.555)/(130.5) = 1.609$  [from Table 3.2]

$E_r = 0.955$  [from Section 3.2]

$B_r = 7.173$  [from Table 2.1]

Decommissioning Cost (1998 Dollars)  
= (\$105 million)\*[(0.65)\*(1.609)+(0.13)\*(0.955)+(0.22)\*(7.173)]  
= \$289 million

#### Example 4 (LLW Disposition by Waste Vendors)

##### Scenario Description

Reactor Type: BWR  
Thermal Power Rating: 3400 MW<sub>th</sub>  
Location of Plant: Midwest Region of the U.S.  
LLW Disposition Preference: Contract with Waste Vendors  
LLW Burial Location: South Carolina

Base Cost (1986 Dollars) = \$135 million [from 10 CFR 50.75(c)(1)]

$L_r = (136.9)^*(1.409)/(125.0) = 1.543$  [from Table 3.2]

$E_r = 0.939$  [from Section 3.2]

$B_r = 6.968$  [from Table 2.1]

Decommissioning Cost (1998 Dollars)  
= (\$135 million)\*[(0.65)\*(1.543)+(0.13)\*(0.939)+(0.22)\*(6.968)]  
= \$359 million

#### 4 References

1. Konzek, G. J., and R. I. Smith, "Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station - Technical Support for Decommissioning Matters Related to Preparation of the Final Decommissioning Rule," (Report prepared by Pacific Northwest Laboratory, Richland, Washington), NUREG/CR-0130, Addendum 4, U.S. Nuclear Regulatory Commission, July 1988.
2. Konzek, G. J., and R. I. Smith, "Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station - Technical Support for Decommissioning Matters Related to Preparation of the Final Decommissioning Rule," (Report prepared by Pacific Northwest Laboratory, Richland, Washington), NUREG/CR-0672, Addendum 3, U.S. Nuclear Regulatory Commission, July 1988.
3. U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, "Report on Waste Burial Charges - Escalation of Decommissioning Waste Disposal Costs at Low-Level Waste Burial Facilities," NUREG-1307, Revision 7, November 1997.
4. U.S. Department of Labor, Bureau of Labor Statistics, *Monthly Labor Review*, Table 24, Updated Periodically.
5. U.S. Department of Labor, Bureau of Labor Statistics, *Producer Price Indexes*, Table 6, Updated Periodically.

**Appendix A**

**LLW Burial/Disposition Prices for the Current Year**

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## Appendix A

## Appendix A

## LLW Burial/Disposition Prices for the Current Year

This appendix contains the price schedules for burial/disposition of low-level wastes at the Washington and South Carolina sites for the year 1998. Also provided are vendor price quotes for disposition of LLW generated by the decommissioning of nuclear power plants. These schedules are used to calculate the results shown in Appendix B used to develop the waste burial adjustment factor,  $B_w$ , for the year 1998.

**A.1 Washington LLW disposal Site**

Beginning in 1993, the Northwest Compact imposed on eligible (Northwest or Rocky Mountain Compact) waste generators an annual permit fee based on the volume of waste to be shipped to the Washington site for disposal. In 1998, the annual permit fee ranges from \$400 to \$40,000. Hospitals, universities, research centers, and industries pay the lower fees, and nuclear power plants pay the highest fee of \$40,000 per year. The permit fees for nuclear power plants are included in this analysis for the years 1993 and later.

Beginning in 1994, the rate schedule for handling and disposing of heavy objects (greater than 5,000 pounds) at the Washington site was revised to recover additional crane rental costs from the waste generator. In 1996, the heavy object limit was raised to 17,500 pounds. A series of shipments of heavy objects for disposal was assumed that would minimize the crane surcharge and result in only a one-time heavy object charge.

Effective January 1, 1996, the operator of the Washington site implemented a restructured rate schedule based on waste volume, number of shipments, number of containers, and dose rate at the container surface. Each waste generator is also assessed an annual site availability charge based on cumulative volume and dose rate at the surface of all containers disposed. The site availability charge appears near the bottom of Tables B.1 through B.3.

In 1997, and again in 1998, the operator of the Washington site more than tripled rate charges on containers having surface dose rates in excess of 100 R/hr. The overall increase arising from these two increases is about a factor of 11. These large increases affect the overall burial costs for a BWR reactor more than for a PWR reactor since the BWR usually has more highly irradiated components than a PWR.

Exhibit A.1 provides the current rate schedule for the Washington LLW disposal site, effective May 1, 1998.

**A.2 South Carolina LLW Burial Site**

At the South Carolina site, during the period of January 1, 1993 through June 30, 1994, the Southeast Compact imposed the collection of access fees of \$220/R<sup>2</sup> from all eligible out-of-region waste generators. Eligible generators were those in compact regions or unaffiliated states that were in compliance with the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPA). Large waste generators (greater than 1,500 cubic feet for that period) were assessed an access fee based on their waste volume projection for that period. One-sixth of the access fee was paid in advance on a quarterly basis. Large waste generators from the Southeast Compact states paid an access fee of \$74/R<sup>2</sup>.

Access to the South Carolina site by waste generators outside the Southeast Compact ended June 30, 1994, with site closure scheduled for December 31, 1995. However, effective July 1, 1995, the scheduled closure was canceled and access to the Barnwell facility was extended to all states except North Carolina.

Effective November 1, 1996, the operator of the South Carolina disposal site implemented a restructured waste disposal rate schedule. The restructured pricing is based on weight, dose rate, and curies with a cost incentive toward higher density packaging. All business after November 1, 1996, will be through customer-specific contracts.

## Appendix A

Effective July 1, 1998, the operator of the South Carolina disposal site imposed a site access fee on users which varies according to their level of use. Access fees for large users (e.g., utilities with nuclear plants) average about \$205,000 per year. The site access fee appears near the bottom of Table B.10 for the South Carolina disposal site.

Exhibit A.2 provides the current rate schedule for the South Carolina LLW disposal site, effective January 1998.

### A.3 LLW Disposition by Waste Vendors

Rapidly increasing fees for disposal of low-level radioactive waste has spawned the creation of a niche market for firms specializing in the management of LLW. Increasingly, licensees of nuclear power plants are outsourcing LLW management functions to these waste vendors for a negotiated fee (usually \$/pound of LLW processed). The degree to which LLW management functions are outsourced is negotiated on a case-by-case basis. Waste vendors can manage all LLW management functions from time of generation to disposal (including packaging, transportation, and volume reduction) or any subset of these functions as desired by the licensee.

The vendor determines the most efficient disposition process for each waste stream, which may include sorting into clean/contaminated streams, recycling where possible, volume reduction via the many techniques currently commercially available, and disposal of the residual LLW at the most cost effective disposal site. The vendor's profit is the difference between the price negotiated with the licensee and the total cost for waste minimization, recycling, volume reduction, packaging, transportation, and disposal. The more effective the vendor is at minimization, recycling, volume reduction, and obtaining volume discounts for packaging, transportation, and disposal, the greater will be the profit.

Currently, there are approximately 10 waste vendors operating in the United States. Clearly, waste management costs at nuclear power plants are being reduced through the use of waste vendors. Also, closer attention to LLW management by power plant licensees has resulted in dramatic reductions of LLW being disposed of at the commercial LLW burial sites. Since publication of NUREG/CR-0130 and NUREG/CR-0672, the average

annual LLW volume disposed of by nuclear power plants has decreased by an order of magnitude. This volume reduction has been achieved through a combination of increased efforts to minimize the volume of LLW generated to begin with and increased use of waste vendors to reduce the volume of disposed LLW.

The trend of utilizing waste vendors by licensees of operating nuclear power plants is also now being observed at nuclear power plants being decommissioned. Table A.1 shows the disposition destination for LLW generated between 1993 and 1997 during the decommissioning of the Yankee Rowe Nuclear Power Plant (NPP). Over 60% of the waste generated during the decommissioning of this plant was contracted to waste vendors for disposition.

The decommissioning analyses reported in NUREG/CR-0130 and NUREG/CR-0672 did not consider the possible use of waste vendors given that this market niche essentially did not exist at the time. Since the use of waste vendors has clearly become an accepted practice by the nuclear power industry for operations and decommissioning since that time, this update of NUREG-1307 includes an alternative that provides for contracting with waste vendors to manage the disposition of certain portions of LLW generated during decommissioning. This new alternative does not modify or alter in any way the bases for the decommissioning fund requirement specified in 10 CFR 50.75. It merely provides another burial cost adjustment factor ( $B_2$ ) that reflects LLW disposition by waste vendors.

In support of this analysis, several waste vendors were surveyed to develop a representative cost for waste vendor services. Each of the vendors was asked to provide a generic price quote for processing two waste streams: activated/contaminated concrete and contaminated metal. They were asked to provide these quotes as a price per pound of waste, or as a range of price per pound, based on the waste concrete and metal inventories in NUREG/CR-0130 and NUREG/CR-0672. The price quotes were to encompass complete disposition of these waste streams (from generation to disposal) and were to be developed assuming the vendor had a contract with a licensee engaged in a large decommissioning project.

Five vendors provided price quotes in response to the survey. The price quotes are provided in Table A.2. For confidentiality reasons, the vendors providing the data are not identified.

## Appendix A

The vendor prices used to calculate the waste burial/disposition cost factors,  $B_x$ , for both PWR and BWR were \$1.50/lb for activated/contaminated concrete and \$2.00/lb for contaminated metal. These were developed by taking the average of the three mid-range values in Table A.2 and rounding the result up to the next half dollar. In order to minimize the effect of differences in assumptions in what the vendors did or did not include in their price quotes, both the low and high price quotes were eliminated from the average price calculation.

This analysis assumed that disposition of dry active waste (DAW) was contracted by waste vendors at the same price as activated/contaminated concrete. All liquid radioactive waste and activated metal are dispositioned as assumed in NUREG/CR-0130 and NUREG/CR-0672 or, in other words, they go directly to disposal without further

processing. The resulting  $B_x$  will be conservative for the following reasons:

- the waste vendor prices used are at the upper range of the price quotes provided and
- the waste vendor quotes included packaging and transportation of LLW, which are already included in the labor and energy cost elements, respectively, of the 10 CFR 50.75 algorithm.

Also, when utilization of waste vendors is more cost effective than direct disposal, the resulting  $B_x$  will further be conservative because at least some of the activated metal could be dispositioned more economically through the services of a waste vendor.

**Table A.1 Disposition Destination of Yankee Rowe NPP LLW<sup>(a)</sup>**

LLW Destination	LLW Volume (ft <sup>3</sup> )	LLW Volume (% of Total)
South Carolina Disposal Site	30,867	21.1
Utah Disposal Site	22,390	15.3
Waste Vendors	92,428	63.3
Liquid LLW Vendors	385	0.3
Total	146,070	100.0

(a) Reference: NRC Public Document Room (PDR) under NUREG-1307, Revision 8

**Table A.2 Price Quotes for Waste Vendor Services<sup>(a)</sup>**

Vendor	Activated/Contaminated Concrete (\$/lb)	Contaminated Metal (\$/lb)
Vendor #1	0.55 - 0.89	0.87 - 1.50
Vendor #2	1.50 - 2.00	2.50 - 3.00
Vendor #3	1.00 - 1.50	1.50 - 1.75
Vendor #4	0.24 - 0.31	1.57 - 1.70
Vendor #5	1.72	1.85

(a) Reference: NRC Public Document Room (PDR) under NUREG-1307, Revision 8

## Appendix A

## Exhibit A.1

US ECOLOGY, INC.  
RICHLAND, WASHINGTON FACILITY  
RADIOACTIVE WASTE DISPOSAL

DISPOSAL CHARGES  
EFFECTIVE MAY 1, 1993  
SCHEDULE A, EIGHTH REVISION

Note: Rates in this schedule A are subject to adjustment in accordance with the rate adjustment mechanism adopted in the Commission's sixth supplemental order in Docket No. UR-950619. These rates reflect the third year of a three-year phase-in of a revised rated design, in accordance with the stipulation accepted by the Commission in its fifth supplemental order in Docket No. UR-950619.

A. SITE AVAILABILITY CHARGE

## 1. Rates

Block	Block Criteria	Annual Charge per Generator
0	No site use at all	\$ 65
1	Greater than zero but less than or equal to 10 ft <sup>3</sup> and 50 mR/h	201
2	Greater than 10 ft <sup>3</sup> or 50 mR/h* but less than or equal to 20 ft <sup>3</sup> and 100 mR/h*	384
3	Greater than 20 ft <sup>3</sup> or 100 mR/h* but less than or equal to 40 ft <sup>3</sup> and 200 mR/h*	739
4	Greater than 40 ft <sup>3</sup> or 200 mR/h* but less than or equal to 80 ft <sup>3</sup> and 400 mR/h*	1,419
5	Greater than 80 ft <sup>3</sup> or 400 mR/h* but less than or equal to 160 ft <sup>3</sup> and 800 mR/h*	2,731
6	Greater than 160 ft <sup>3</sup> or 800 mR/h* but less than or equal to 320 ft <sup>3</sup> and 1,600 mR/h*	5,250
7	Greater than 320 ft <sup>3</sup> or 1,600 mR/h* but less than or equal to 640 ft <sup>3</sup> and 3,200 mR/h*	10,091
8	Greater than 640 ft <sup>3</sup> or 3,200 mR/h* but less than or equal to 1,280 ft <sup>3</sup> and 6,400 mR/h*	18,398
9	Greater than 1,280 ft <sup>3</sup> or 6,400 mR/h* but less than or equal to 2,560 ft <sup>3</sup> and 12,800 mR/h*	37,295
10	Greater than 2,560 ft <sup>3</sup> or 12,800 mR/h* but less than or equal to 5,120 ft <sup>3</sup> and 25,600 mR/h*	71,898
11	Greater than 5,120 ft <sup>3</sup> or 25,600 mR/h*	137,614

\* For purposes of determining the site availability charge, mR/hour is calculated by summing the mR per hour at container surface of all containers received during the year.

## 2. Exemptions

a. As to waste which is generated for research, medical or educational purposes, educational research institutions shall be placed in a rate block for the site availability charge which is one (1) lower than what would otherwise apply through application of the block criteria shown above. "Educational research institution" means a state or independent not-for-profit, postsecondary educational institution.

b. As to waste which arises as residual or secondary waste from brokers' provision of compaction or processing services for others, if application of the block criteria shown above would place a broker in a rate block for the site availability charge which is greater than Block No. 7, such broker shall be placed in the rate block which is the greater of (i) Block No. 7, or (ii) the block which is two (2) lower than what would otherwise apply through application of the block criteria shown above. "Brokers" are those customers holding the "broker" classification of site use permits issued by the Department of Ecology.

## 3. Payment Arrangements

## a. Initial Determination

Initial determination as to the applicable rate block for each customer shall be based on projections provided by customers prior to the beginning of each calendar year. For those customers who do not intend to ship waste to the facility during the calendar year (those assigned to block No. 0) and for those customers who are initially determined to fall into block Nos. 1-2, the entire site availability charge for the year will be due and payable as of January 1. For those customers who are initially determined to fall into block Nos. 3-8, the entire site availability charge will also be due and payable as of January 1, although those customers may make special arrangements with the Company to pay the charge in equal installments at the beginning of each calendar quarter. For those generators who are initially determined to fall in block Nos. 9-11, 1/12 of the site availability charge will be due and payable as of the beginning of each calendar month. These customers may pay in advance if they wish.

## b. Reconciliation

The site availability charge is assessed on the basis of actual volume and dose rate of waste delivered during the calendar year. Assessment of additional amounts, or refunds of overpaid amounts, will be made as appropriate to reconcile the initial determination regarding applicable rate block with the actual volume and dose rates during the calendar year.

Appendix A

**Exhibit A.1 (Continued)****SCHEDULE A (Continued)****US ECOLOGY, INC.  
RICHLAND, WASHINGTON FACILITY  
RADIOACTIVE WASTE DISPOSAL RATES****EFFECTIVE MAY 1, 1998****B. DISPOSAL RATES**

1. Volume: \$30.60 per cubic foot
2. Shipment: \$8,280 per manifested shipment
3. Container: \$1,158 per container on each manifest
4. Exposure:

Block No.	Dose Rate at Container Surface	Charge per Container
1	Less than or equal to 200 mR/h	\$ 133
2	Greater than 200 mR/h but less than or equal to 1,000 mR/h	9,550
3	Greater than 1,000 mR/h but less than or equal to 10,000 mR/h	37,600
4	Greater than 10,000 mR/h but less than or equal to 100,000 mR/h	58,500
5	Greater than 100,000 mR/h	950,000

**EXTRAORDINARY VOLUMES**

Waste shipments qualifying as an "extraordinary volume" under RCW 81.108.020(3) are charged a rate equal to 51.5% of the volume disposal rate.

**NUCLEAR DECOMMISSIONING WASTE**

The volume disposal rate applicable to waste from the decommissioning of nuclear generating units shall be 80% of those set forth above; provided, however, that such waste must satisfy the quantity requirements for "extraordinary volume" under RCW 81.108.020(3).

**SCHEDULE B  
Surcharges and Other Special Charges  
Third Revision****ENGINEERED CONCRETE BARRIERS**

72" x 8' barrier	\$7,006.00 each
84" x 8' barrier	\$8,828.00 each

**SURCHARGE FOR HEAVY OBJECTS**

The Company shall collect its actual labor and equipment costs incurred, plus a margin thereon of 25%, in handling and disposing of objects or packages weighing more than seventeen thousand five hundred (17,500) pounds.

**SCHEDULE C  
Tax and Fee Rider  
Tenth Revision**

The rates and charges set forth in Schedules A and B shall be increased by the amount of any fee, surcharge or tax assessed on a volume or gross revenue basis against or collected by US Ecology, as listed below:

Perpetual Care and Maintenance Fees	\$1.75 per cubic foot
Business & Occupation Tax	3.3% of rates and charges
Site Surveillance Fee	\$5.00 per cubic foot
Surcharge (RCW 43.200.233)	\$5.50 per cubic foot
Commission Regulatory Fee	1.0% of rates and charges

-end-

## Appendix A

## Exhibit A.2



Chem-Nuclear Systems, L.L.C.

## Barnwell Low-Level Radioactive Waste Management Disposal Facility Pricing Schedule Example

All radwaste material shall be packaged in accordance with Department of Transportation and Nuclear Regulatory Commission Regulations in Title 49 and Title 10 of the Code of Federal Regulations, Chem-Nuclear Systems, L.L.C.'s Nuclear Regulatory Commission and South Carolina Radioactive Material Licenses, Chem-Nuclear Systems, L.L.C.'s Barnwell Site Disposal Criteria, and amendments thereto:

1. BASE DISPOSAL CHARGES (not including surcharges):

A. Standard and Special Nuclear Material (SN) waste:

1.	<u>Weight</u>	<u>Rate</u>
a.)	Greater than 120 lbs./ft <sup>3</sup>	Upon Request
b.)	Greater than 75 lbs./ft <sup>3</sup> and less than 120 lbs./ft <sup>3</sup> density	\$ 4.40 per pound
c.)	Greater than 60 lbs./ft <sup>3</sup> and less than 75 lbs./ft <sup>3</sup> density	\$ 5.40 per pound
d.)	Greater than 45 lbs./ft <sup>3</sup> and less than 60 lbs./ft <sup>3</sup> density	\$ 7.00 per pound
e.)	Less than 45 lbs./ft <sup>3</sup>	\$ 7.00 per pound times the ratio of 45 lbs/ft <sup>3</sup> divided by package density

2. Millicurie Charge \$ .30 per millicurie

B. Biological Waste \$ 1.00 per pound, in addition to above rates

C. Utility Specific Base Disposal Charges (based on submission of LLRW Profile Sheets) To be determined Upon Evaluation of Specific Utility Waste Quantity/Type

- 1 -

Battelle, Pacific Northwest National Laboratory

EXAMPLE FOR ESTIMATING USE ONLY  
PRICING IS SUBJECT TO CHANGE

Appendix A

**Exhibit A.2 (Continued)****Chem-Nuclear Systems, L.L.C.****NOTES:**

Note 1: Maximum Millicurie Charge is \$120,000.00 per shipment.

Note 2: The minimum charge per shipment, excluding surcharges and specific other charges, is \$1,000.00.

Note 3: Base disposal charge includes:

**2. EXTENDED-CARE FUND**

Included in Rates

**3. SOUTH CAROLINA LOW-LEVEL RADIOACTIVE WASTE DISPOSAL TAX:**

Included in Rates

**4. SITE STABILIZATION AND CLOSURE FUND:**

All waste disposed

Included in Rates

**5. TECHNOLOGY CHARGE:**

For all waste in "A" vaults.

Included in Rates

**6. SURCHARGES:****A. Dose Rate Surcharge**

Dose Level		Multiplier of Base Weight Rate
0	200 mR/hr	1.00
200 mR/hr	1 R/hr	1.08
1R/hr	2R/hr	1.12
>2R/hr	3R/hr	1.17
>3R/hr	4R/hr	1.22
>4R/hr	5R/hr	1.27
>5R/hr	10R/hr	1.32
>10R/hr	25R/hr	1.37
>25R/hr	50R/hr	1.42
>50R/hr		1.48

B. Items which do not conform to one of the above categories

Upon Request

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Battelle, Pacific Northwest National Laboratory

EXAMPLE FOR ESTIMATING USE ONLY  
PRICING IS SUBJECT TO CHANGE

## Appendix A

## Exhibit A.2 (Continued)



Chem-Nuclear Systems, L.L.C.

## C. Irradiated Hardware Charges

Per Shipment

\$ 30,000.00

## D. Irradiated Cask-Handling Fee

Included in Item 6.c.

## E. Special Nuclear Material Surcharge

Upon Request

7. MISCELLANEOUS:

- A. Transport vehicles with additional shielding features may be subject to an additional handling fee which will be provided upon request.
- B. Decontamination services, if required: \$150.00 per man hour, plus supplies at current Chem-Nuclear rate.
- C. Customers may be charged for all special services as described in the Barnwell Site Disposal Criteria.
- D. Terms of payment are NET 30 DAYS upon presentation of invoices. A per-month service charge of one and half percentage (1&1/2%) shall be levied on accounts not paid within 30 days.
- E. Company purchase orders or a written letter of authorization in form and substance acceptable to Chem-Nuclear shall be received before receipt of radioactive waste material at the Barnwell Disposal Site and shall refer to Chem-Nuclear's Radioactive Material Licenses, the Barnwell Site Disposal Criteria, and subsequent changes thereto.
- F. All shipments shall receive a Chem-Nuclear shipment identification number and conform to the Prior Notification Plan.
- G. Class B/C waste received with chelating agents, which require separation in the trench, may be subject to a surcharge if Stable Class A waste is not available for use in achieving the required separation from other wastes.
- H. Material delivered for disposal by Company, from processing of the material at a third party site, may be credited towards the quantity of either Company or the processor, but not both. As the original generator is ultimately responsible for waste disposition, CNSI will abide by the original waste-generator's direction. Material delivered directly from a generator's site will be credit to that generator's account.